

REMARKS

Claims 1-28 are pending and presented for examination in this application. Claims 14, 17-27 are indicated in the office action (paragraph 20, page 7) to be allowable if rewritten in independent form and if the indefiniteness rejection is overcome. Above, Claims 14 and 17 have been rewritten in independent form. As to the above amendment to Claim 1, see, e.g., original claims 12 and 15. Claims 10, 14-15, 17, 23, 26 and 27 have been amended as to matters of style, grammar and/or format.

As to new claim 28 added above, see, e.g., Applicants' specification at page 29, lines 1-5.

The above amendments to the specification are only for correcting typographic errors.

Preliminary Matters

Two preliminary matters are noted. First, the office action was mailed to an address that is not the current correspondence address of record. A copy of the Change of Correspondence Address filed January 22, 2004 is submitted herewith for convenience of reference.

Second, please note the attached Information Disclosure Statement submitted herewith and citing: USP 6,674,954 (2004) (Fuji Photo Film); and US Pat. App. Nos. 10/000,812; 10/067,858; 10/073,958; 10/262,864; 10/397,284; 10/367,814 (Nippon Sheet Glass).

Priority Documents

At paragraph 2, page 2, of the Office Action, the Examiner indicates (incorrectly) that the certified copies of the foreign priority documents have not been filed. The priority documents were filed November 7, 2001. The Examiner is respectfully requested to so acknowledge.

Specification, Drawings

At paragraph 4, page 2, the Examiner has stated that "[t]he specification is objected to as failing to provide proper antecedent basis for the claimed subject matter," citing 37 CFR 1.75(d)(1) and MPEP 608.01(o). The Examiner mentions Claims 10, 15, 26 and 27. To advance prosecution, Applicants have amended Claims 10, 15, 26 and 27 in a manner that Applicants believe obviates the objection(s) of paragraph 4 of the Office Action.

At paragraph 5, page 3 of the Office Action, the Examiner has objected to a typographical

error at page 2, line 1 of the specification. Also in paragraph 5, at page 3 of the Office Action, the Examiner states that on page 3, line 16 of the specification, it is unclear to what "optical axis 5" refers. Above, Applicants have corrected the typographical errors as requested by the Examiner and the objection is believed to be obviated.

At page 3, paragraph 6 of the Office Action, the drawings have been objected to. The Examiner takes the position that the "means for making a mixture of various luminous flux having a plurality of wavelengths incident on an end surface..." must be shown or the feature(s) canceled from the claim(s).

Applicants respectfully traverse. See Applicants' Figure 14, including luminous flux 10 and end surface 2b; see also Applicants' specification at page 32, –line 14. See also Applicants' Fig. 10 including luminous flux 10. Because the drawings do show the claimed feature(s) and thus are believed to not be objectionable, the Examiner is respectfully requested to reconsider and withdraw his objection set forth in paragraph 6 of the Office Action.

At page 3, paragraph 7 of the Office Action, the Examiner has requested that Figure 26 be designated by a legend such as –Prior Art–. In response, Applicants agree that Figure 26 is discussed in the Background of the Invention- section of the specification (page 3), and Applicants agree that Figure 26 may properly be labeled –Background Art–. Attached hereto is Figure 26 so labeled "Background Art." Such attached Figure 26 is believed to obviate the objection of paragraph 7 of the Office Action.

At page 3, paragraph 8 of the office action, an objection to the drawings and specification has been made with regard to item 20 on Fig. 17 etc. and item 15 of Fig. 20 being said to go unmentioned in the description. In response, Applicants have amended their specification at the paragraphs respectively bridging pages 33-34 and pages 34-35. This objection to the drawings is believed to be obviated.

Rejection Under 35 U.S. C. 112, Second Paragraph

At page 4, paragraphs 10-11 of the office action, Claims 14 and 17-27 have been rejected under 35 U.S.C. 112, second paragraph, as being indefinite. The Examiner's position is that Claims 14 and 17 are generally narrative and fail to conform with U.S. practice. To advance

prosecution, Claims 14 and 17 have been rewritten above. Reconsideration and withdrawal of the indefiniteness rejection are respectfully requested.

Anticipation Rejections

At page 4, paragraph 13 of the office action, Claims 1-6 have been rejected under 35 U.S.C. 102(b) as being anticipated by Kosaka et al. ("Superprism phenomena in photonic crystals"). The Examiner cites Fig. 2 and parts of cols. 2-3 of Kosaka et al.

Applicants respond as follows. Applicants' claim 1 as amended recites "An optical device comprising a periodic multilayer structure, wherein an end surface of said multilayer structure which is not parallel to layer surfaces of said multilayer structure is used as at least one of a beam incidence surface and a beam exit surface," with "the periodic multilayer structure being a one-dimensioned photonic crystal."

Kosaka teaches:

(1) a "super prism phenomenon" where the light path shows a drastic wide swing with a slight change of the incident light angle (i.e. large dispersion), because the first band is shaped linearly in a neighbor of the band gap.

(2) They used a three-dimensional-periodic structure as a photonic crystal having three periodic dimension for their experiments and calculations.

Figure 1 of Kosaka shows that a large angle dispersion is limited only in an internal part of the photonic crystal. The luminous flux is not output to the homogeneous material (such as air) on the outside of the crystal. Further, as shown in Fig. 4 of Kosaka, the large dispersion is obtained by the band structure based on two-dimensional periods. The periodic structure in two directions is necessary in Kosaka, although Kosaka uses three dimensional period crystal in the experiments.

However, by contrast, the present invention is directed to only one-dimensional photonic crystal, formation of which is much less expensive than those of two-dimensional or three-dimensional photonic crystals.

Kosaka is silent about application of their presentation to one-dimensional structure. The present invention discloses for the first time that the super prism phenomemon are obtained by a

one-dimensional photonic crystal.

Also, it should be understood that, for providing a practical spectroscope, it is necessary to condense a dispersed luminous flux by a lens or the like. That is, that light flux is necessarily output to the homogeneous material outside the photonic crystal. Thus, Kosaka is even more removed from the present invention.

The invention is advantageous in that the output light flux from the crystal is used directly, because the large dispersion occurs when the light is output to the homogeneous material.

Accordingly, reconsideration and withdrawal of the anticipation rejection based on Kosaka are respectfully requested.

At page 5, paragraph 14 of the office action, Claims 1, 3 and 6-9 have been rejected under 35 U.S.C. 102(b) as anticipated by Inoue et al. (USP 5,033,810). The Examiner cites Fig. 1; Fig. 4b; col. 2, lines 45-67; col. 3, lines 1-5; col. 4, lines 3-40; and col. 6, lines 1-40 of Inoue.

Applicants respectfully traverse the anticipation rejection. In Inoue, (1) the laminated multilayer structure contains a material having a non-linear coefficient; (2) the input light is modulated.

In contrast, in the present invention:

- It is not necessary that the multilayer structure is non-linear material. (Or, the multilayer structure is not non-linear material.)

- Input light is only dispersed according to the frequency and is not modulated.

Thus, the invention is different from Inoue in basic structure. Accordingly, reconsideration and withdrawal of the anticipation rejection based on Inoue are respectfully requested.

At page 5, paragraph 15 of the office action, Claims 1, 3, 6 and 9-11 have been rejected under 35 U.S.C. 102(b) as being anticipated by Normandin et al. (USP 5,111,466). The Examiner cites Figs. 1, 8, 9; col. 3, lines 1-15 and 55-67; col. 6, lines 55-65; and col. 7, lines 15-30 of Normandin.

Applicants respond as following. In Normandin, (1) the multilayer structure is provided as an optically non-linear material. (2) The multilayer structure generates a higher harmonic

wave. (3) Light is input from both sides of the multilayer structure. In Normandin, a harmonic wave is generated, which means light having a changed frequency is output from the multilayer structure.

In contrast, in the present invention:

- It is not necessary that the multilayer structure be non-linear material. (Or, the multilayer structure is not non-linear material.)
- The multilayer structure does not generate different frequency in output light.
- The light is input on one side.

Thus, the invention is different from Normandin in basic structure. Accordingly, reconsideration and withdrawal of the anticipation rejection based on Normandin are respectfully requested.

Obviousness Rejections

At page 6, paragraph 17 of the Office Action, Claim 2 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Normandin in view of Kosaka. The Examiner admits that Normandin "is silent concerning the specific period condition." (Office Action, page 6.)

Applicants traverse the obviousness rejection as follows.

Normandin and Kosaka are not naturally combinable in the manner that the Examiner has argued. Normandin was working with conventional optical multilayer materials made of Al-Ga-As¹, not with photonic crystals, which had not even developed as a field at the time of Normandin's work.

On the other hand, Kosaka was working with silicon and silicon dioxide materials and reporting an extraordinary property of those silicon and silicon dioxide materials, in the new field of "photonic" crystals. To a person of ordinary skill in Applicants' art, Kosaka (regarding a property of a silicon material) is not naturally combinable with Normandin (regarding a non-silicon material, in a non-photonic crystal) in the manner that the Examiner has proposed.

Moreover, although the Examiner has cited Kosaka as allegedly supplying the deficiencies in Normandin, in fact Kosaka even fails to teach or disclose that the length a of one period in a periodic multilayer structure should be set according to: " $\lambda / 2n_M \leq a$," as set forth in

¹Normandin, col. 3, lines 23, 25 27, 29-30 etc.

Applicants' claim 2, that is, that the wavelength divided by twice the average refractive index in the one-period range of said multilayer structure in the wavelength a , should be less than or equal to the length of one period in the periodic multilayer structure. Even with Kosaka and Normandin, a person of ordinary skill in the art still would be far from Applicants' presently claimed invention.

Kosaka's teaching was otherwise. Kosaka's abstract shows that what he was emphasizing as his report was that (at optical wavelength) he could obtain severe angle-sensitive behavior in silicon and silicon dioxide materials. That is, Kosaka was studying the effects of varying angle of incidence; the variable that Kosaka was studying was angle of incidence (not refractive index of a material; not wavelength; not period). What was significant to Kosaka was that he could cause a light path to severely swing from $+70^\circ$ to -70° by only slightly changing the angle of incidence, from $+7^\circ$ to -7° .² Kosaka fails to teach the relationship of Applicants' claim 2 between wavelength, period and refractive index; Kosaka was not even studying those variables together.

In Kosaka's cols. 3-5 (that the Examiner cites in the obviousness rejection), Kosaka fails to teach the relationship between wavelength, refractive index and period length as set forth in Applicants' claim 2.³

Kosaka's teaching was that he could achieve, at optical wavelength, in certain silicon and silicon dioxide materials, the phenomenon of "extraordinary angle-sensitive light propagation, which" Kosaka et al. "call a *superprism phenomenon*" (Kosaka abstract). Kosaka stated, "At present we do not clearly understand the origin of this modified momentum-selection rule..."⁴ The Examiner's assumption that, from Kosaka (relating to special observed properties, expressly said to be not well understood, of two silicon and silicon dioxide samples), it would have been obvious to a person of ordinary skill in the art to have the period in Normandin (relating to Al-Ga-As materials) be equal to or greater than half the ratio of wavelength to the mean

²Kosaka, sentence bridging cols. 1-2.

³Kosaka's mention of a value a which is a lateral lattice constant should not be confused with Applicants' a which is the length of one period in the periodic multilayer structure.

⁴Kosaka col. 5, lines 2-3.

refractive index to have highly modulated band dispersion is not reasonably attributed to such a person of ordinary skill in the art. Kosaka had limited understanding of his data with regard to the actually tested silicon and silicon dioxide materials, and one of ordinary skill in the art would not have been reasonable to extrapolate to other materials.

Thus, the obviousness rejection of claim 2 is founded on several assumptions which cannot properly be made. Wherefore, reconsideration and withdrawal of the obviousness rejection of claim 2 are respectfully requested.

At page 6, paragraph 18 of the office action, Claims 12 and 15 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Normandin in view of Yeh et al. The Examiner admits that Normandin fails to disclose a one-dimensional photonic crystal. (Office Action, page 6.) On this point, the Examiner cites Yeh, at page 425, col. 1, lines 5-10.

Applicants respectfully traverse this obviousness rejection of claims 12 and 15.

Yeh at page 425, col. 1 cited by the Examiner does not tell a person of ordinary skill in the art what the Examiner cites Yeh (on General Theory of Electromagnetic propagation in periodic stratified media) as showing. That is, a person of ordinary skill in the art reading Yeh's page 425 and Normandin is not in fact instructed to use a one-dimensional photonic crystal and arrive at Applicants' presently claimed invention of claim 12 or 15. Yeh (1977) addresses conventional optical crystals, not "photonic" crystals. Nor does Normandin disclose a "photonic" crystal. A "photonic" crystal cannot be presumed-into Yeh or Normandin. Nor can the specific dimensionality of photonic crystal, one-dimensioned, be implied. The development of "photonic" crystals has only been recent. As another company that is not the present assignee wrote in an application filed in 2000 that issued as a U.S. patent this year, it was "very recently" that "photonic crystal ... having a different optical characteristic from that of the conventional optical crystal has been effectively developed." USP 6,674,954 (2004) (Fuji Photo Film). The Yeh article (1977) and the Normandin patent (issued in the U.S. in 1992 based on a Canadian application filed in 1990) were before the time of "photonic" crystals and those two references would not be read by a person of ordinary skill in Applicants' art as relating to "photonic" crystals.

Accordingly, reconsideration and withdrawal of the obviousness rejection of claims 12 and 15 are respectfully requested.

At page 7, paragraph 19 of the office action, Claims 13 and 16 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Normandin in view of Yeh further in view of Kosaka. The Examiner admits that Normandin and Yeh "are silent concerning the specific period condition." (Office action, page 7.)

Applicants respectfully traverse this obviousness rejection. As set forth above, Normandin and Yeh are more removed from the presently claimed invention than the Examiner has admitted. Normandin and Yeh fail to teach a one-dimensional photonic crystal, but rather, relate to conventional (non-photonic) optical crystals. Applicants also incorporate by reference their above remarks regarding Kosaka. A person of ordinary skill in Applicants' art would not be motivated to combine Normandin, Yeh and Kosaka in the manner that the Examiner has argued; moreover, even with the three references, such a person still would fall short of the invention of Applicants' claims 13 and 16. Accordingly, reconsideration and withdrawal of the obviousness rejection of claims 13 and 16 are respectfully requested.

In view of the foregoing, it is respectfully requested that the application be reconsidered, that claims 1-28 be allowed, and that the application be passed to issue.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephone or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition

and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Michael E. Whitham", written over a horizontal line.

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FIG.26
BACKGROUND ART

